Well, Well, Well...

Goals: To help students understand how water moves underground, how a well works to recover groundwater, and how withdrawal of groundwater can affect the water table.

Subjects: Science, Home Economics, Environmental Science

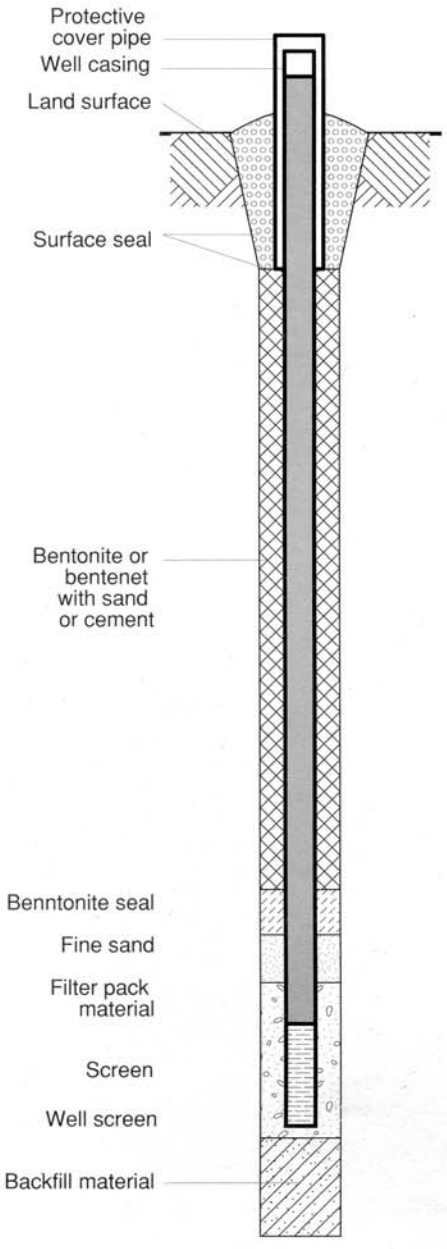
DPI Objectives: SC: A1, A2, B3, B5

EH: C1, C4

Grades: 6-9

Materials:

- Well, Well, Well... activity sheet



Monitoring Well

- one 10 gallon aquarium (may be adapted for 5 gallon aquarium)
- one 5 gallon bucket filled with coarse, clean sand
- one quart of aquarium gravel
- one piece 1" wide diameter plastic tubing
- three pieces 1/3" outside diameter glass tubing:
  - one piece, 20" long
  - two pieces, 4" long
- two pieces 1/3" outside diameter rubber tubing:
  - one piece 3' long
  - one piece 2' long
- two glass rods 12" long (or similar diameter wooden dowels)
- two #7 rubber stoppers:
  - one 1-holed
  - one 2-holed
- one 500 milliliter Erlenmeyer glass flask
- one hand pump/siphon*
- small nail
- watering can or spray bottle
- 3" X 3" piece of cheesecloth
- small rubber band
- aquarium glue
- green food coloring
- 5 gallons of water

* available at sporting goods stores, pet shops and hardware stores

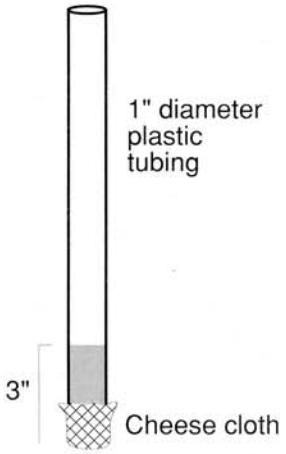
Background: *Wells* are constructed to bring groundwater to the land surface so we can use it (or monitor its quality). Holes are drilled and pipes put in the ground to a depth below the water table. Pumps are connected to the well pipe so that water in and around the well is drawn up the pipe and into a house or wherever the water is used.

Following are instructions for constructing a well model. You can use the model to demonstrate how surface water soaks into the ground to become groundwater and how a pump recovers water. By adding food coloring to represent a contaminant, you can also use the model to demonstrate how groundwater can become polluted.

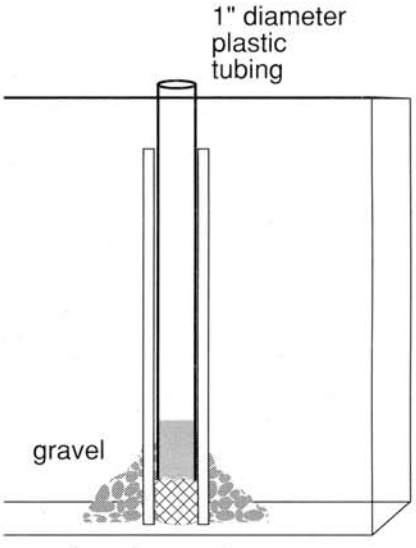
Procedure:

A) Preparation.

1. Using a small nail, make approximately 30 1/16" diameter holes beginning at one end of the 1" diameter plastic tubing and extending three inches from that end. Cover the bottom of the tube with cheesecloth and secure with a small rubber band. This will prevent sand from entering the bottom of the tube later.



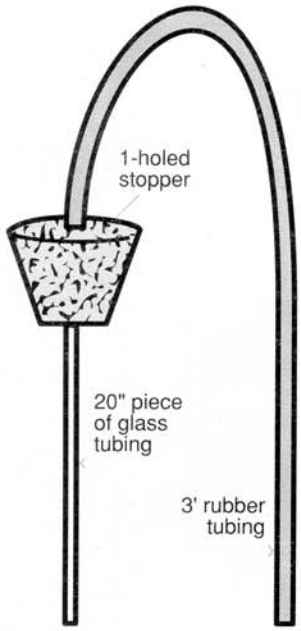
2. Using aquarium glue, attach the two glass rods (or dowels) and the 1" diameter plastic tube to the long side of the aquarium perpendicular to the bottom. Allow glue to dry.



glass rods

3. Place gravel so that all holes at the bottom of the 1" diameter plastic tubing are covered. The gravel will help keep sand from entering the well during pumping.

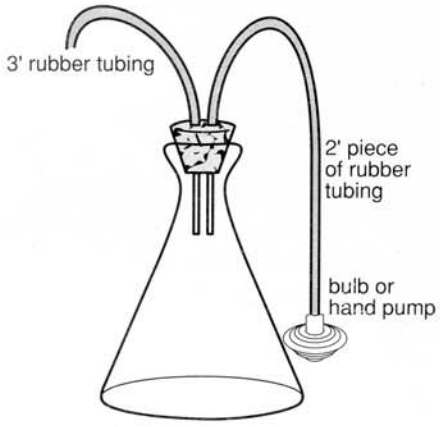
4. Insert the 20" piece of glass tubing into the one-holed stopper so that the tube extends one to two inches above the top of the stopper.



5. Attach one end of the 3' rubber tubing to glass tube extending out of the stopper.

6. Insert this assembly into the 1" plastic tube in aquarium.

7. Insert two 4" pieces of glass tubing into holes of 2-holed stopper so that 1" of tubing extends above the stopper. Attach the loose end of 3' rubber tubing to one of the glass tubes extending from 2-holed stopper.



8. Attach one end of 2' piece of rubber tubing to the other glass tube extending from the stopper.

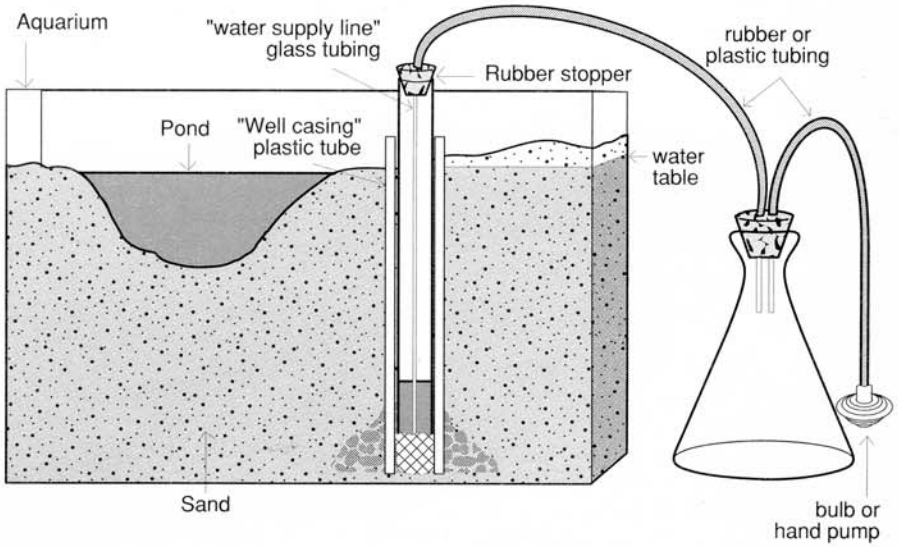
9. Insert stopper into the flask.

10. Attach the hand pump/siphon to the other end of the 2' tubing. Check that all connections are airtight.

11. The model works best when the flask is positioned lower than the aquarium to create a continuous siphon thus eliminating the need to continuously pump.

12. Fill the aquarium 1/2 to 3/4 full with sand. Create a depression in sand opposite to the well. This simulates a pond or lake.

13. Add water to the aquarium so that it's about 1/2 full. The completed model should look like the illustration below.



B) Demonstration.

1. Discuss the model. Identify the groundwater and the water table. Begin to slowly pump water from the well. Note the level of the water table and pond surface. As the surface level of the pond is lowered, a rain storm may be simulated by pouring water from a watering can over the land and water.

2. Experiment with more rainfall ("recharge") than pumping to simulate a wet year, and with more pumping ("withdrawal") than rainfall to simulate a drought. Groundwater "overdraft" occurs when the rate of withdrawal of water is greater than recharge, resulting in a lowering of the water table. Observe the runoff and infiltration. When you are finished with the experiments, continue pumping until the flask is full.

3. Empty the flask and "pollute" the pond with green food coloring. Continue the demonstration with polluted water (food coloring represents a water soluble pollutant). Point out that, unlike food coloring, many contaminants don't change the color, odor or taste of water. These contaminants are difficult to detect. Many other pollutants may be filtered out by soil or broken down by chemical or physical processes before they reach groundwater. Notice also that the dyes in the food coloring move at different rates through the soil.

Note: If using model for consecutive classes, leave time to flush dye pollutant from model (by adding water and pumping) or work dye contaminant into next demonstration, e.g. have students determine the source of contamination, find how much water/how much pumping is required to remove contaminant, etc.

C) Discussion.

1. Complete the activity sheet. Discuss your answers.

More ways to use your groundwater model

1. **Fertilizer/Pesticide Model:** Build the groundwater model as directed. Sprinkle powdered grape drink mix on the surface to represent fertilizer or pesticide put on a field. Sprinkle water over the surface to simulate rain. Observe and discuss.

2. **Landfill/Abandoned Waste Site Model:** Roll a paper towel into a ball and saturate it with food coloring. Bury it just beneath the surface to represent an improperly designed or abandoned waste disposal site. Pour water on the surface. Observe and discuss.

3. **Leaking Underground Storage Tank Model:** Fill a film canister with colored water and puncture it in several places with a pin. Bury it just beneath the surface (not along the side of the box). Pour water on the surface. Observe and discuss.

4. **Abandoned Well Model:** Puncture a drinking straw in several places with a pin and plug the bottom with clay. Bury the straw, plugged end down, in the sand to represent an abandoned well. Pour colored water into the abandoned well. Pump from the working well. Observe and discuss.

5. **Leaky Lagoon Model:** Cut the bottom off a small paper cup and puncture the bottom in several places with a pin. Partially bury the cup bottom in the sand to simulate a settling lagoon. Fill the lagoon with colored water. Pump from your well. Observe and discuss.

From: ***Groundwater Resources and Educational Activities for Teaching.*** *1989. Iowa Department of Natural Resources.*

Going Beyond:

1. Contact a licensed well driller (a list is available from your local DNR office). Arrange a field trip to a drilling site. Ask driller to show and discuss the drilling record. Using a flashlight, look down the new well (attach flashlight to a string to make sure it isn't lost down the well).

Attach a cork to a fishing line and lower down well to measure depth of the water table. When the cork floats, mark the spot on the fishing line that is even with the top of the well casing. Pull the line up and measure the length of line from the mark to the cork and subtract the distance that the casing extends above the ground. The resulting distance is the depth of the water table from the ground surface.

Compare your measurement to the well driller's measurement.

Repeat your field trip when the well, pump and piping are complete and ask driller to explain how well and pressure tank work to bring water to the surface. Ask well driller to explain a "pitless adapter." Inspect the adapter with a flashlight. Collect a water sample for bacterial and nitrate analysis.

Adapted from: ***Groundwater Study Guide****. 1984. Wisconsin Department of Natural Resources, Bureau of Information and Education.*

A 2-dimensional Plexiglass Groundwater Flow Demonstration Model is available from the Central Wisconsin Groundwater Center. See Resources.

Well, Well, Well activity sheet

1. How do wells bring groundwater to the surface?

2. What happens to the water table as water is pumped from the ground?

3. What must happen for the water table to remain at the same level when water is being pumped out?

4. How do pollutants move from surface water into groundwater? (Note: Groundwater can be recharged—and polluted—by surface water, especially if large volumes of water are being pumped from the ground, but surface water usually represents a "discharge area" where groundwater comes to the surface and evaporates into the atmosphere.)

5. How can pollutants be detected in well water? Can all pollutants be detected?

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